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(54) **Waste products' disposal method**

(57) The present invention relates to the area of ecology, namely to the methods for the treatment waste products comprising mainly explosive and toxic chemicals, in particular for the disposal of waste products from industrial-military systems. The method proposed in the present invention for the treatment of waste products includes mixing said waste products with a microorganisms' culture adapted to the substances to be treated, together with a biological stimulator of the microorgan-

isms' growth; and ageing obtained substrate; and seeding aged substrate with a rain forest worms's culture of hybrid form based on genre *Eisenia*; wherein nitro organic explosives are employed as the substance to be disposed of; alimentary waste products and/or waste products related to the wood industry are used as biological stimulators of the microorganisms' growth.

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## Description

**[0001]** The present invention relates to the area of ecology, namely to the methods for the disposal of waste products comprising mainly explosive and toxic chemicals, in particular for the disposal of waste products from industrial-military systems.

**[0002]** The question regarding disposal of artillery explosives, rocket fuels, substances containing trinitrotoluene and hexogen, toxic chemical reactivities and reagents whose safety storage term has expired, and especially substances whose composition determination causes significant difficulties, poses a question of extreme urgency to the inhabitants of many countries. Furthermore, the decision through methods known in the art concerning industrial redevelopment (reconversion) pursuing other purposes or productions of enterprises involved in the industrial-military system, in military testing areas, in storage zones of explosive, toxic and unknown chemical agents, turns complicated due to the inevitable destruction of the natural environment.

**[0003]** Methods for elimination of chemical weapons are known from state of the art, including chemical destruction of toxic substances. Document RU 2203116, 27.04.2003, reveals a biological processing of sewage and catalytic oxidation of formed gases.

**[0004]** Furthermore, there is also a known technique of biologic neutralization of explosives by means of the introduction of microorganisms into them, capable of transforming materials with a highly explosive energy into lesser explosives or even into non explosives ones. This technique includes the biological neutralization of such substances, as organic nitroaromatic compounds, organic nitragins or organic nitroethers. The examples of organic nitroaromatic compounds include TNT, hexanitro-stilbene (HNS), hexanitroso-benzene (NAB), diamine-trinitro-benzene (DATB) and triamine-trinitro-benzene (TATV). Examples of organic nitroamines include RDX, HMX, nitroguanidine (NQ) and 2,4,6-trinitrophenylmethyl nitramine (tettil). The examples of organic nitroethers include PETN, nitro-glycerine and ethylenglicol dinitrate.

**[0005]** Examples of microorganisms which are confirmed for the elimination of these substances, include groups consisting of *Pseudomonas* spp., *Escherichia* spp., *Morganella* spp., *Rhodococcus* spp., *Comamonas* spp., and denitrifying microorganisms. The use of any combination of said separate microorganisms or any other microorganisms determined as being capable of the biological elimination of explosive materials is within the scope of the present invention. Applicable microorganisms *Pseudomonas* spp. include microorganisms of the group consisting of *aeruginosa*, *fluorescens*, *acidovorans*, *mendocina*, *cepacia* and those of a not identified type (see document RU, 2210729, 20.08.2003).

**[0006]** A complex equipment arrangement, larger consumptions of electric energy and chemical agents, and the phenols' formation in the biological destruction of the above-mentioned groups of microorganisms, not allowing the use of the obtained product in the national economy thus requiring further processing, are outstanding as deficiencies of the above mentioned methods.

**[0007]** The removal of nitrogen-containing heterocyclic or aromatic compounds comprising at least one nitro group is a thoroughly well known method. The method consists in the conversion of at least one nitro group in an amino group by contacting a dilution of the leaving compound with a microorganism of the type *Bacillus licheniformis* (see document RU 2216524, 20.11.2003)

**[0008]** The dilution implementation of the aforementioned method will form amines which must be deleted from runoff later on.

**[0009]** On the opposite, methods of toxic waste products' disposal allowing the production of useful products are more complete.

**[0010]** Processing waste products is a thoroughly known method, for example, in paper and/or cardboard production which envisages previous composting of organic waste products with the complementary introduction of manure as a source of active microorganisms and ferments, as well as the introduction of extracts and autolysates of beer-houses or bakery yeast, or even self yeast as sources of nitrogen through mixing during a 7-12 days' period, resulting in a puerile compost which before composting with worms, is mixed with waste products of cellulose-paper or such related to the wood industry, with an additional quantity of nitrogen sources in a perforated vessel, so that obtained worms' compost would have a final rate of carbon and nitrogen of 10 to 50 parts per 1000 parts of compost, a 10% molasses content and worms, but particularly performing the control during mixing of the fermentative activity of the worms' compost mixture (see RU 2290389, 27.12.2006).

**[0011]** However, this method is not suitable for explosives' disposal.

**[0012]** The method for the disposal of waste products according to which domestic wastes are treated with microorganisms, afterwards colonized through culture of rain forest worms, is closest to the technical essence and achieved results. A suspension of aerobic thermophilic microorganisms is used as microorganisms for processing waste products, which is added at temperatures from 55 to 69°C. Regarding the culture, a culture of rain forest worms of the genre *Eisenia*, type *foetida* and red californian hybrid is used (see RU 2201911, 10.04.2003r.)

**[0013]** The shortcoming of this method is a significant energy consumption regarding temperature maintenance and continuous aeration.

**[0014]** The object of the present invention is the development of a method allowing the treatment of a broad range of toxic waste products, including those involved in the industrial-military system, including those of explosives, with the obtention of humus, not comprising pathogen microflora and toxic organic substances.

**[0015]** Said object is solved by the presently explained method of waste products' disposal including the mixture of waste products with microorganisms culture adapted to the substances to be treated; and including a biological stimulator of the microorganisms' growth, ageing said obtained substrate and adding to said substrate a rain forest worms's culture of hybrid form based on the genre *Eisenia*. According to the presently claimed method nitro organic explosives are employed as the substance to be treated and alimentary waste products and/or waste products related to the wood industry are used as biological stimulators of the microorganisms' growth, increasing the humidity of the obtained mixture up to 25-35%; introducing afterwards a microorganisms collection population adapted at room temperature to the explosive to be treated; letting obtained substrate stand for 12 to 15 days before seeding it with said rain forest worm's culture.

**[0016]** Mixing of initial components is preferably carried out at the following mass percent rates (% m/m.):

|                                                     |                |
|-----------------------------------------------------|----------------|
| Substances to be disposed of -                      | from 20 to 40  |
| Microorganisms adapted to substances to be treated- | from 5 to 10   |
| Microorganisms' growth biological stimulator -      | from 75 to 50. |

**[0017]** Preferably, seeding of substrate of rain forest worm's culture of hybrid form on the basis of the genre *Eisenia* perform at a rate of 100 pieces over 1 CM<sup>3</sup> of substrate volume.

**[0018]** Preferably, before mixing disposed waste products were complementarily exposed to acoustic processing in a range from 10 to 100 kHz for no longer than 50 min.

**[0019]** Examples of the method for the treatment of specific explosives with microorganisms collections population which do not limit the scope of the present method are herewith presented later on.

#### Example 1

**[0020]** A processing test of the explosive trotyl was carried out under laboratory conditions. For this purpose 50 gr. of trotyl pulverized in water to a powder state with size of fractions not above 0,2 MM were blended with 150 gr. of organic waste products from squeezed tomatoes, grapes, apples, meat effluents and pulverized wood particles, increasing at the same time the humidity of the mixture up to 30%. The obtained mixture was stirred again and then microorganisms collections population from bacteria, actinomycetes and imperfect fungi adapted to trotyl were added. A rain forest worms' culture of hybrid form based on the *Eisenia* genre was transferred after 14 days to the obtained substrate. Said rain forest worm's culture was entered at the rate of 100 pieces over 1 CM<sup>3</sup> of substrate.

**[0021]** Similarly hexogen and tetril were processed under laboratory conditions. The disposal process controlled by means of chemical analysis and visual data is shown in Table 1.

**[0022]** As it is obvious from Table 1 percentage of explosives, namely hexogen, trotyl and tetril are considerably reduced by seeding the collection's population of microorganisms from bacteria, actinomycetes and imperfect fungi from 12 to 15 days, though further ageing does not provide a significant curtail of said contents. After seeding worm's culture, the whole processing of hexogen occurred in 90 days, of trotyl in 80 days and tetril in 120 days. Humus, not comprising toxic compounds, was obtained as a result of the present waste disposal method.

Table 1

| Microorganisms' seeding collection populations |           |          |          |
|------------------------------------------------|-----------|----------|----------|
| Days                                           | Hexogen % | Trotyl % | Tetril % |
| 10                                             | 89        | 85       | 91       |
| 12                                             | 87        | 84       | 89,5     |
| 14                                             | 86,5      | 81,5     | 88,5     |
| 15                                             | 86        | 80       | 88       |
| 16                                             | 85,9      | 79       | 87,95    |
| After seeding worm's culture                   |           |          |          |
| 20                                             | 70        | 64       | 74       |

(continued)

| After seeding worm's culture |        |        |        |
|------------------------------|--------|--------|--------|
| 30                           | 44     | 32     | 49     |
| 45                           | 23     | 15     | 28     |
| 60                           | 11     | Traces | 17     |
| 80                           | Traces | 0      | 8      |
| 90                           | 0      |        | Traces |
| 120                          |        |        | 0      |

**Example 2**

**[0023]** A disposal test of sovtol' (trade name of a PCB product of former USSR) was conducted under laboratory conditions.

**[0024]** For this purpose 100 gr. of sovtol were mixed with 900 gr. of organic waste products consisting of squeezed tomatoes, grapes, apples, meat effluents and pulverized wood particles. 1500 ml. of water were added to the obtained mixture attaining a 35% humidity of same. Then, to the obtained and thoroughly mixed mixture, a population of microorganisms from bacteria, actinomycetes and imperfect fungi adapted to sovtol was seeded. A rain forest worms' culture of hybrid form based on the *Eisenia* genre was transferred after a few days to the obtained substrate. Said rain forest worm's culture was entered at the rate of 100 pieces over 1 CM<sup>3</sup> of substrate.

**[0025]** A second sovtol processing experiment was carried out similarly to the above described, but first the 100 gr. of sovtol were exposed to preliminary acoustic processing by ultrasound with a frequency of 40 kHz during 3 min. Obtained data are shown in table 2.

**Table 2**

| Days                    | Total dioxine' contents, % (without acoustic processing) | Total dioxine' contents, % (with preliminar acoustic processing) |
|-------------------------|----------------------------------------------------------|------------------------------------------------------------------|
| 7                       | 95                                                       | 84                                                               |
| 15                      | 88                                                       | 71                                                               |
| After adding vermiculit |                                                          |                                                                  |
| 45                      | 51                                                       | 31                                                               |
| 60                      | 42                                                       | 24                                                               |
| 80                      | 38                                                       | 13                                                               |
| 90                      | 21                                                       | 9                                                                |
| 120                     | 12                                                       | Traces                                                           |
| 150                     | Traces                                                   |                                                                  |

**[0026]** As it is evident from table 2 the preliminary acoustic processing of sovtol considerably curtails whole processing time span of waste products. The disposal process, just like in example 1, was controlled by means of chemical analysis and visual data. As a result of the present waste disposal humus, not comprising toxic compounds, was obtained.

**Claims**

1. A method for the disposal of waste products including the mixture of waste products with microorganisms culture adapted to the substances to be treated, together with a biological stimulator of the microorganisms' growth; ageing the obtained substrate; and seeding aged substrate with a rain forest worm's culture of hybrid form based on genre *Eisenia* **characterized in that** it comprises the steps of: employing nitro organic explosives as the substance to be treated; using alimentary waste products and/or waste products related to the wood industry as biological stimulators of the microorganisms' growth; increasing the humidity of the obtained mixture up to 25-35%; introducing afterwards

a population of microorganisms adapted at room temperature to the explosive to be treated; letting obtained substrate stand for 12 to 15 days before adding to it said rain forest worm's culture.

2. The method according to claim 1, further comprising the step of mixing initial components in a percent rate (m/m.):

substances to be treated - from 20 to 40 ,  
microorganisms adapted to substances to be treated - from 5 to 10  
biological stimulator of the microorganisms' growth - from 75 to 50.

3. The method according to claim 1, wherein seeding the substrate of rain forest worm's culture of hybrid form based on genre *Eisenia* is performed at a rate of 100 pieces over 1 CM<sup>3</sup> of the substrate volume.

4. The method according to claim 1, wherein before mixing waste to be treated is exposed to preliminary acoustic processing in a range from 10 up to 100 kHz for not more than 50 min.

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- RU 2203116 [0003]
- RU 2210729 [0005]
- RU 2216524 [0007]
- RU 2290389 [0010]
- RU 2201911 [0012]